

**INSTRUCTIONS****A. General:**

1. This Question Booklet is your Question Paper.
2. This Question Booklet contains **28** pages and has 100 questions.
3. Answer **ALL** questions.
4. The Question Booklet **Code** is printed on the right-hand top corner of this page.
5. The Question Booklet contains blank spaces for your rough work. No additional sheets will be provided for rough work.
6. **Clip board, log tables, slide rule, calculator, cellular phone, pager and electronic gadgets in any form are NOT allowed.**
7. Write your **Name** and **Roll Number** in the space provided at the bottom.
8. All answers are to be marked only on the machine gradable Objective Response Sheet (**ORS**) provided inside this booklet, as per the instructions therein.
9. The Question Booklet along with the Objective Response Sheet (**ORS**) must be handed over to the Invigilator before leaving the examination hall.

**B. Filling-in the ORS:**

10. Write your Roll Number in the boxes provided on the upper left-hand-side of the **ORS** and darken the appropriate bubble under each digit of your Roll Number using a **HB pencil**.
11. Ensure that the **code** on the **Question Booklet** and the **code** on the **ORS** are the same. If the codes do not match, report to the Invigilator immediately.
12. On the lower-left-hand-side of the **ORS**, write your Name, Roll Number, Name of the Test paper, Name of the Test Centre and put your signature in the appropriate box with ball-point pen. Do not write these anywhere else.

**C. Marking of Answers on the ORS:**

13. Each question has **4 choices** for its answer: (A), (B), (C) and (D). Only **ONE** of them is the correct answer.
14. On the right-hand-side of **ORS**, for each question number, darken with a **HB Pencil**, **ONLY** one bubble corresponding to what you consider to be the most appropriate answer, from among the four choices.
15. There will be **negative marking** for wrong answers.

**MARKING SCHEME:**

- (a) For each question, you will be awarded **3 (three)** marks, if you have darkened only one bubble corresponding to the correct answer.
- (b) In case you have not darkened any bubble for a question, you will be awarded **0 (zero)** mark for that question.
- (c) In all other cases, you will be awarded **-1 (minus one)** mark for the question.

Name .....

Roll Number

|                      |                      |                      |                      |                      |                      |                      |                      |
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**Special Instructions / Useful Data**

Atomic No.: B, 5; C, 6; N, 7; O, 8; F, 9; Ni, 28; Zn, 30; Br, 35; Cd, 48;  
Pt, 78.

$$\ln 2 = 0.693$$

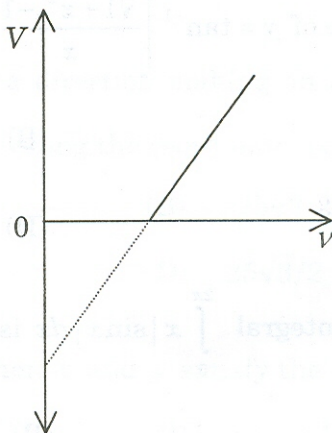
**DO NOT WRITE ON THIS PAGE**

1. Let  $1 < x < \infty$  and  $f(x) = \log\left(\frac{x+1}{x-1}\right)$ . Then  $f\left(\frac{x^3+3x}{1+3x^2}\right)$  equals
- (A)  $f(x+3)$  (B)  $f(x^2+3)$   
 (C)  $2f(x)$  (D)  $3f(x)$
2. Let  $P(x)$  be the polynomial of least degree with rational coefficients and  $1+\sqrt{5}$  is a root of  $P(x)=0$ . Then  $P(x)$  is
- (A)  $x^2-2x+4$  (B)  $x^2+2x+4$   
 (C)  $x^2+2x-4$  (D)  $x^2-2x-4$
3. Let  $C$  be the circle passing through the origin with its centre lying on the straight lines  $3x-2y=0$  and  $x+y-5=0$ . Then the equation of  $C$  is
- (A)  $x^2+y^2+4x+6y=0$  (B)  $x^2+y^2+4x-6y=0$   
 (C)  $x^2+y^2-4x-6y=0$  (D)  $x^2+y^2-4x+6y=0$
4. The range of a random variable  $X$  is  $\{0, 1, 2, 3, \dots\}$  and the probabilities of  $X$  are given by  $P(X=0) = \frac{1}{e}$ ,  $P(X=k) = \frac{c^k}{k!e}$ ,  $k=1, 2, 3, \dots$ , where  $c$  is a constant. Then  $P(0 < X < 2)$  is
- (A)  $1/e$  (B)  $4/e$   
 (C)  $2/e$  (D)  $3/e$
5. Let  $x, y$  be real numbers,  $\vec{a} = \hat{i} + \hat{j} - \hat{k}$ ,  $\vec{b} = \hat{i} - \hat{j} + \hat{k}$  and  $\vec{c} = x\hat{i} + y\hat{j} - \hat{k}$ . If  $\vec{c}$  is perpendicular to  $\vec{a}$  and  $\vec{c} \cdot \vec{b} = -4$ , then which one of the following is **TRUE**?
- (A)  $x=2, y=1$  (B)  $x=-2, y=-1$   
 (C)  $x=2, y=-1$  (D)  $x=-2, y=1$
6. The value of  $\lim_{x \rightarrow 2} \frac{2^{x+1} + 2^{4-x} - 12}{2^{6-x} - 2^{3+x} + 16}$  is
- (A)  $-1/12$  (B)  $1/12$   
 (C)  $-1/6$  (D)  $1/6$

7. A wire of length 50 cm is to be cut into two pieces for making a square and a circle. For their combined area to be a minimum, one of the pieces must have a length (in cm.) of
- (A)  $\frac{200\pi}{\pi+4}$  (B)  $\frac{100\pi}{\pi+4}$   
 (C)  $\frac{200}{\pi+4}$  (D)  $\frac{100}{\pi+4}$
8. The solution of the differential equation  $x \frac{dy}{dx} - y = 2x \ln x, x > 0$  subject to the condition  $y(1) = 0$  is
- (A)  $x^2 \ln x$  (B)  $x (\ln x)^2$   
 (C)  $x^2 (\ln x)^2$  (D)  $x \ln x$
9. A force of magnitude 50 N acts in a direction making an angle of  $30^\circ$  with the positive  $x$ -axis. Then the components (in N) along the coordinate axes OX and OY are
- (A) 25, 25 (B)  $25\sqrt{3}, 25$   
 (C) 25,  $25/2$  (D)  $25\sqrt{3}/2, 25/2$
10. Let  $z = x + iy$  and  $|z - i| = |z + 1|$ . Then  $x$  and  $y$  satisfy the equation
- (A)  $x - y = 1$  (B)  $x + y = 1$   
 (C)  $x + y = 0$  (D)  $x - y = 0$
11. The value of  $\cos^4\left(\frac{\pi}{8}\right) + \cos^4\left(\frac{3\pi}{8}\right)$  is
- (A)  $1/4$  (B)  $1/2$   
 (C)  $3/4$  (D) 1
12. If  $n \geq 2$  and  $(1+x)^n = a_0 + a_1x + a_2x^2 + \dots + a_nx^n$ , then the value of the expression  $a_0 + 2a_1 + 3a_2 + 4a_3 + \dots + (n+1)a_n$  equals
- (A)  $2^{n-1}(n+2)$  (B)  $2^n n$   
 (C)  $2^{n-1}(n+1)$  (D)  $2^{n-2}(n+7)$

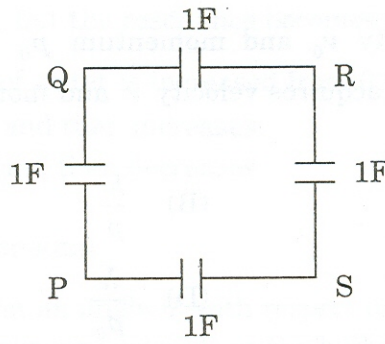
13. The distance of the point  $(1, 2, 1)$  from the plane  $3x - 6y + 2z + 7 = 0$  is
- (A) 1 (B) 0  
(C)  $1/7$  (D)  $2/7$
14. The value of the determinant  $\begin{vmatrix} 1+xy & 1 & 1 \\ 1 & 1+yz & 1 \\ 1 & 1 & 1+zx \end{vmatrix}$  equals
- (A)  $(x + y + z)(x + y + z + xyz)$  (B)  $xyz(x + y + z + xyz)$   
(C)  $xyz(x + y + z)$  (D)  $xyz(xy + yz + zx)$
15. The value of the derivative of  $y = \tan^{-1} \left[ \frac{\sqrt{1+x^2}-1}{x} \right]$ ,  $x \neq 0$  at  $x = 1$  is
- (A)  $\frac{1}{4-2\sqrt{2}}$  (B)  $\frac{1}{4+2\sqrt{2}}$   
(C)  $1/2$  (D)  $1/4$
16. The value of the definite integral  $\int_0^{2\pi} x |\sin x| dx$  is
- (A)  $2\pi$  (B)  $3\pi$   
(C)  $4\pi$  (D)  $\pi$
17. A particle is projected at an angle of elevation  $45^\circ$  with a velocity of 1 unit. Then the horizontal distance covered is ( $g$  denotes the acceleration due to gravity)
- (A)  $g$  (B)  $2/g$   
(C)  $g/2$  (D)  $1/g$
18. The maximum value of  $7x + 10y$  subject to the constraints  $x + 3y \geq 3$ ,  $x + y \leq 2$  and  $x \geq 0, y \geq 0$  is
- (A) 20 (B) 10  
(C) 14 (D) 15.5

19. A simple pendulum of mass  $m$  and length  $l$  is given a horizontal velocity  $v$  when it is at rest in the equilibrium position. Let  $v^2 = gl$ , where  $g$  is the acceleration due to gravity. The angle from the vertical at the turning point is
- (A)  $\pi/3$  (B)  $\pi/4$   
 (C)  $\pi/6$  (D)  $\pi/2$
20. Figure below shows the variation of stopping potential ( $V$ ) as a function of frequency ( $\nu$ ) of the incident radiation in a photoelectric experiment. If the intensity of the incident radiation is increased, then in the graph

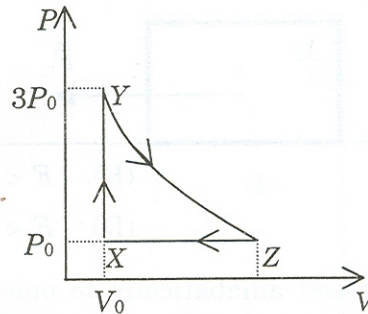


- (A) the slope alone changes  
 (B) the  $V$ -intercept alone changes  
 (C) both the slope and  $V$ -intercept remain the same  
 (D) both the slope and  $V$ -intercept change
21. A hydrogen atom in the 3<sup>rd</sup> excited state can have
- (A) 3 Lyman, 2 Balmer and 1 Paschen transitions  
 (B) 2 Balmer and 1 Paschen transitions  
 (C) 2 Lyman and 1 Paschen transitions  
 (D) 2 Lyman, 3 Balmer and 1 Paschen transitions

22. Four capacitors (each of  $1\text{ F}$ ) are connected as shown in the figure. If the capacitor assembly is charged to  $V$  volts by connecting to the points P and R, the total energy stored in the assembly is

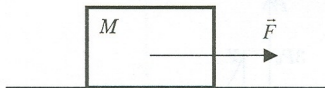


- (A)  $2V^2$  (B)  $\frac{1}{2}V^2$   
 (C)  $4V^2$  (D)  $V^2$
23. Figure shows the  $P$ - $V$  diagram for an ideal gas. If the system has a temperature  $T_0$  at  $X$ , the temperature at  $Y$  is



- (A)  $T_0$  (B)  $2T_0$   
 (C)  $3T_0$  (D)  $4T_0$
24. The first overtone of an open organ pipe of length  $l$  was found to be the same as that of the fundamental frequency of a closed organ pipe when the pipe was immersed in water upto a certain level. Then, the water fills the tube upto a level of
- (A)  $\frac{1}{4}l$  (B)  $\frac{3}{4}l$   
 (C)  $\frac{1}{2}l$  (D)  $\frac{2}{3}l$

25. For obtaining a **REAL** image using a biconvex lens of focal length  $f$ , the distance  $d$  between the object and the image must satisfy the condition
- (A)  $d = \infty$  only (B)  $2f < d < 4f$   
 (C)  $0 < d < 2f$  (D)  $d \geq 4f$
26. An electron having initial velocity  $v_0$  and momentum  $p_0$  is accelerated in a constant electric field  $\vec{E}$ . After a time  $t$ , it acquires velocity  $v$  and momentum  $p$ . The change in the wavelength of the electron is
- (A)  $\frac{h|v - v_0|}{p_0}$  (B)  $\frac{h}{p}$   
 (C)  $\frac{h|v - v_0|}{p_0 v}$  (D)  $\frac{h}{p_0}$
27. If the biasing is changed from forward to reverse across a semiconductor  $p$ - $n$  junction, the width of the depletion layer
- (A) decreases (B) does not change  
 (C) vanishes (D) increases
28. A force  $\vec{F}$  is applied to a block of mass  $M$  resting on a surface, as shown in the figure. The coefficient of static friction between  $M$  and the surface is  $\mu_s$ . If the mass **DOES NOT** move, then



- (A)  $F > \mu_s Mg$  (B)  $F < \mu_s Mg$   
 (C)  $F = Mg$  (D)  $F < Mg$
29. When an ideal gas is compressed adiabatically to one-fourth of its original volume, the pressure increases by 8 times. The ratio of the molar heat capacities ( $C_p / C_v$ ) of the gas can be
- (A) 1.4 (B) 1.67  
 (C) 1.45 (D) 1.5
30. Consider two simple harmonic motions represented by  $x_1 = A_0 \cos(\omega t + \delta)$  and  $x_2 = A_0 \cos(\omega t)$ . At  $t = 0$ ,  $x_1 = -A_0$ . If these two simple harmonic motions are combined, the amplitude of the resultant motion is
- (A) zero (B)  $2A_0$   
 (C)  $\frac{A_0}{2}$  (D)  $\sqrt{2}A_0$



31. When the resistance  $R$  in an LCR circuit is increased, the resonance frequency of the circuit
- increases, but the resonance becomes broader
  - decreases, but the resonance becomes sharper
  - remains the same, but the resonance becomes sharper
  - remains the same, but the resonance becomes broader

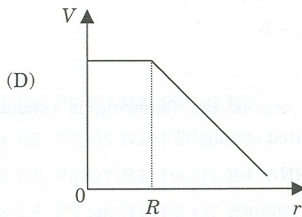
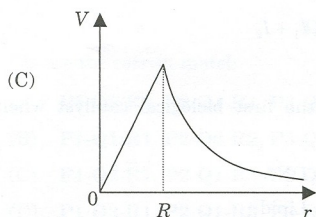
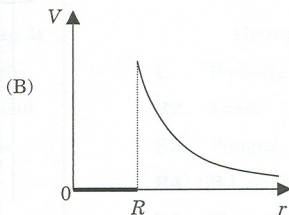
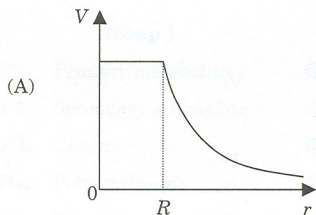
32. When the temperature of water is increased from  $0^\circ\text{C}$ , its
- volume decreases and then increases
  - volume increases and then decreases
  - volume increases
  - volume remains constant

33. A projectile is launched at an angle  $\theta$  with respect to the horizontal with an initial velocity  $u$ . The coordinates of the moving projectile at the highest point are

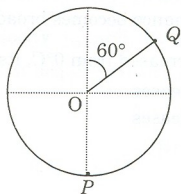
(A)  $\left(\frac{u^2 \sin 2\theta}{g}, \frac{u^2 \sin^2 \theta}{2g}\right)$       (B)  $\left(\frac{u^2 \sin 2\theta}{2g}, \frac{u^2 \sin^2 \theta}{g}\right)$

(C)  $\left(\frac{u^2 \sin 2\theta}{2g}, \frac{u^2 \sin^2 \theta}{2g}\right)$       (D)  $\left(\frac{u^2 \sin 2\theta}{g}, \frac{u^2 \sin^2 \theta}{g}\right)$

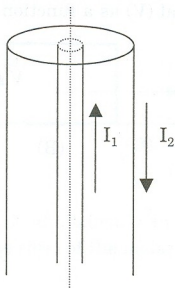
34. If a conducting sphere of radius  $R$  is given a charge  $Q$ , which one of the following graphs represents the variation of potential ( $V$ ) as a function of distance ( $r$ ) from the centre of the sphere



35. A particle of mass  $m$  tied to a string is made to move in a circular path of radius  $R$  in a VERTICAL plane. Neglect the air friction and mass of the string. Total work done on the particle when the particle moves from  $P$  to  $Q$  is



- (A)  $mgR$  (B)  $\frac{3}{2}mgR$   
 (C)  $\left(1 + \frac{\sqrt{3}}{2}\right)mgR$  (D) Zero
36. Currents  $I_1$  and  $I_2$  flow in opposite directions along two long coaxial tubes as shown in the figure. The magnetic field at any point in the annular region depends on



- (A)  $I_2$  only (B)  $I_1$  only  
 (C)  $I_1 - I_2$  (D)  $I_1 + I_2$
37. Which one of the following is considered to be the first biological catalyst when life originated on earth?
- (A) RNA (B) DNA  
 (C) Protein (D) Lipid

38. "Portuguese man-of-war" belongs to the phylum
- (A) Porifera (B) Cnidaria  
(C) Annelida (D) Arthropoda
39. If an animal has biradial symmetry, then it has
- (A) only one plane of symmetry  
(B) two axes of rotational symmetry  
(C) two planes of symmetry; these two planes have no specific relationship to each other  
(D) two planes of symmetry; these two planes are at right angles to each other
40. A population is isolated by a geographical barrier. The resulting speciation known as
- (A) parapatric (B) allopatric  
(C) sympatric (D) pseudopatric

41. Consider the following Groups:

**Group I :** Class of compounds

**Group II :** Typical examples for **Group I**

**Group III :** Organism / cell associated with the production of these compounds

| Group I                         | Group II                 | Group III                |
|---------------------------------|--------------------------|--------------------------|
| <b>P1.</b> Primary metabolite   | <b>Q1.</b> Antibiotic    | <b>R1.</b> Bacteria      |
| <b>P2.</b> Secondary metabolite | <b>Q2.</b> Amino acid    | <b>R2.</b> Yeast         |
| <b>P3.</b> Enzyme               | <b>Q3.</b> Cellulose     | <b>R3.</b> Fungus        |
| <b>P4.</b> Polysaccharide       | <b>Q4.</b> Lignin        | <b>R4.</b> B Lymphocytes |
| <b>P5.</b> Recombinant protein  | <b>Q5.</b> Lipase        | <b>R5.</b> Plant Cells   |
| <b>P6.</b> Immunoglobulins      | <b>Q6.</b> Human insulin |                          |
|                                 | <b>Q7.</b> IgG           |                          |

Choose the correct match.

- (A) P1-Q2-R2, P2-Q1-R1, P3-Q5-R3, P4-Q4-R5, P5-Q3-R3, P6-Q7-R4  
(B) P1-Q1-R1, P2-Q2-R2, P3-Q3-R3, P4-Q4-R5, P5-Q5-R1, P6-Q6-R4  
(C) P1-Q2-R1, P2-Q1-R3, P3-Q6-R4, P4-Q3-R5, P5-Q7-R5, P6-Q1-R4  
(D) P1-Q2-R1, P2-Q1-R3, P3-Q5-R2, P4-Q3-R5, P5-Q6-R1, P6-Q7-R4

42. Which one of the following modifications targets the proteins selectively to lysosomes?

- (A) Addition of N-acetylgalactosamine to a serine residue of the protein
- (B) Addition of a precise number of mannose residues to the protein
- (C) Phosphorylation of a specific mannose residue to mannose-6-phosphate
- (D) Addition of a peptide signal sequence to the N-terminus of the protein

43. Consider the following three groups:

**Group I:** Viruses

**Group II:** Associated diseases

**Group III:** Nature of genetic material – single stranded (ss) or double stranded (ds)  
DNA/RNA

| Group I                          | Group II               | Group III        |
|----------------------------------|------------------------|------------------|
| <b>P1.</b> HIV                   | <b>Q1.</b> Common cold | <b>R1.</b> ssRNA |
| <b>P2.</b> Herpes virus          | <b>Q2.</b> Cancer      | <b>R2.</b> ssDNA |
| <b>P3.</b> Rhinovirus            | <b>Q3.</b> Diarrhea    | <b>R3.</b> dsRNA |
| <b>P4.</b> Rotavirus             | <b>Q4.</b> AIDS        | <b>R4.</b> dsDNA |
| <b>P5.</b> Human papilloma virus | <b>Q5.</b> Chickenpox  |                  |

Choose the correct match.

- (A) P1-Q2-R1; P2-Q3-R2; P3-Q1-R3; P4-Q5-R4; P5-Q4-R4
- (B) P1-Q4-R1; P2-Q5-R4; P3-Q1-R1; P4-Q3-R3; P5-Q2-R4
- (C) P1-Q4-R1; P2-Q5-R2; P3-Q1-R3; P4-Q3-R4; P5-Q2-R2
- (D) P1-Q2-R3; P2-Q3-R1; P3-Q4-R2; P4-Q1-R1; P5-Q5-R4

44. A class of spermicides (used for contraception) inhibits the flagellar motion of the sperm thereby preventing it from swimming towards the egg. This is achieved by

- (A) inhibiting the motor protein dynein
- (B) inhibiting the motor protein kinesin
- (C) disrupting the microfilaments
- (D) depolymerizing microtubules

45. Which one of the following signaling pathways is **CORRECT**?
- (A) Signal  $\rightarrow$  GPCR  $\rightarrow$  G-Protein  $\rightarrow$  Adenyl cyclase  $\rightarrow$  cAMP  $\rightarrow$  Protein kinase A  $\rightarrow$  Cellular response
- (B) Signal  $\rightarrow$  G-Protein  $\rightarrow$  GPCR  $\rightarrow$  Phospholipase C  $\rightarrow$  Inositol triphosphate (IP3)  $\rightarrow$  IP3-gated calcium channel  $\rightarrow$  Release of  $\text{Ca}^{2+}$  ions
- (C) Hormone diffusion  $\rightarrow$  Hormone-receptor (HR) complex  $\rightarrow$  Nuclear transport of HR complex  $\rightarrow$  G-protein modification of HR complex (Transcription Factor)  $\rightarrow$  Binding of Transcription Factor to DNA  $\rightarrow$  Transcription of a gene
- (D) Signal  $\rightarrow$  GPCR  $\rightarrow$  G-Protein  $\rightarrow$  Tyrosine kinase  $\rightarrow$  Protein phosphorylation  $\rightarrow$  cAMP  $\rightarrow$  Cellular response

46. Which one of the following can be used to transfect DNA into mammalian cells?

- P.** Liposomes  
**Q.** Cholesterol  
**R.**  $\text{CaCl}_2$  + HEPES buffer (calcium phosphate)  
**S.** Magnesium chloride

- (A) Only **P** (B) **P** and **Q**  
 (C) **P** and **R** (D) **P** and **S**

47. Choose the correct set of matches between **Groups I** and **II**.

- | <b>Group I</b>                            | <b>Group II</b>                |
|---|--------------------------------|
| <b>P.</b> One extra copy of chromosome 13 | <b>1.</b> Edwards syndrome     |
| <b>Q.</b> XO                              | <b>2.</b> Klinefelter syndrome |
| <b>R.</b> XXY                             | <b>3.</b> Patau syndrome       |
| <b>S.</b> One extra copy of chromosome 21 | <b>4.</b> Down syndrome        |
|   | <b>5.</b> Turner syndrome      |
| (A) <b>P-1, Q-5, R-3, S-2</b>             | (B) <b>P-3, Q-5, R-2, S-4</b>  |
| (C) <b>P-2, Q-1, R-3, S-4</b>             | (D) <b>P-4, Q-1, R-2, S-5</b>  |

48. Which one of the following events **DOES NOT** take place in the lumen of the endoplasmic reticulum in a eukaryotic cell?

- (A) Translation of a mRNA to the corresponding polypeptide chain  
 (B) Folding of the polypeptide chain  
 (C) Post-translational modifications of the polypeptide chain  
 (D) Phospholipid synthesis

49. Rowland and Molina were awarded the Nobel Prize in Chemistry for the year 1995 for their model which states that
- (A) chlorine monoxide, monoatomic chlorine and monoatomic oxygen produced from chlorofluorocarbons react with atmospheric ozone to cause destruction of ozone layer
  - (B) ocean's capacity to absorb additional carbon dioxide is limited, resulting in global warming
  - (C) acid rains are the major problems to countries which burn more coal and gasoline in the process of industrialization
  - (D) UV light damages DNA
50. In some goats, the presence of horns is produced by an autosomal allele that is dominant in males and recessive in females. A horned female is crossed with a hornless male. One of the resulting F1 females is crossed with a hornless male. Then,
- (A) all male progeny and none of the female progeny will be horned
  - (B) all female progeny and none of the male progeny will be horned
  - (C) 50% of the male progeny and none of the female progeny will be horned
  - (D) 50% of the female progeny and none of the male progeny will be horned
51. An enzymatic reaction following Michaelis-Menten kinetics ( $K_m = 50 \mu\text{M}$ ) converts 10% of the substrate (initial concentration  $S_0 = 1 \text{ mM}$ ) to the product in 5 minutes. The maximum reaction velocity (in  $\mu\text{M}/\text{minute}$ ) of the enzyme is approximately
- (A) 10
  - (B) 20
  - (C) 50
  - (D) 180
52. Four mutant strains of *E. coli* having the following characteristics were isolated:

**Mutant strain 1:** lac-repressor is not able to bind to operator because of a mutation in the operator region of the *lac* operon

**Mutant strain 2:** Allolactose is not able to bind to repressor because of a mutation in the repressor-encoding gene

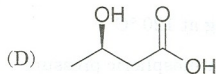
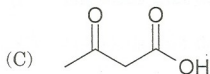
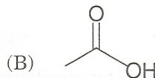
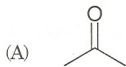
**Mutant strain 3:** Catabolite activator protein (CAP) is not able to bind to the promoter because of a mutation in the promoter region

**Mutant strain 4:** cAMP is not able to bind to CAP because of a mutation in the CAP-encoding gene

*lac* Genes are expressed in strain(s)

- (A) 1 only
- (B) 1, 3, and 4 only
- (C) 1 and 4 only
- (D) 1 and 2 only, but in the presence of IPTG

53. 8 M urea solution became cold when it was prepared by dissolving an appropriate amount of urea in water at room temperature. This is because the dissolution of urea is
- (A) exothermic and exergonic                      (B) exothermic and endergonic  
 (C) endothermic and exergonic                      (D) endothermic and endergonic
54. In the pentose phosphate pathway, glucose is first converted to ribulose-5-phosphate by oxidative decarboxylation. Then, ribulose-5-phosphate undergoes
- (A) further oxidation  
 (B) reduction  
 (C) further decarboxylation  
 (D) only rearrangements of carbon skeleton
55. Which one of the following statements is **TRUE**?
- (A) All microarrays are DNA microarrays  
 (B) Complete genome sequence should be known to make a microarray  
 (C) All the microarrays use radioisotopes  
 (D) Microarrays can be used to measure mRNA levels
56. The metabolite that is **NOT** used by brain as a source of energy under conditions of prolonged low blood-glucose levels is



57. Which one of the following protects membrane lipids against damage by reactive oxygen species produced in the chloroplast?
- (A) Carotenoids (B) Chlorophyll  $\alpha$   
(C) Chlorophyll  $b$  (D) Phycocyanin
58. A DNA sequencing reaction was performed with the fragment 5'-XXXXGCGATCGYYYY-3' as the template, dideoxy GTP, all the four dNTPs, and the required primers and enzyme. XXXX and YYYY in the given DNA fragment represent primer binding sites. The set of fragments obtained during the reaction will be (the primers are not shown in the amplified fragments)
- (A) 5'-CGATCGC-3' only  
(B) 5'-CG-3', 5'-CGCTAG-3', 5'-CGCTAGC-3'  
(C) 5'-CG-3', 5'-CGATCG-3', 5'-CGATCGC-3'  
(D) 5'-G-3', 5'-GCG-3', 5'-GCGATCG-3'
59. According to the Linnean system of biological classification, the term "Hominidae" indicates
- (A) class (B) order  
(C) family (D) genus
60. The endosperm in an angiosperm plant is
- (A) haploid (B) diploid  
(C) triploid (D) tetraploid
61. The technique appropriate for sterilizing animal tissue culture media is
- (A) filtering through a 0.45  $\mu\text{m}$  filter  
(B) autoclaving at 120 °C  
(C) boiling at atmospheric pressure  
(D) using chemical agents



62. Which two of the following statements are **TRUE** in relation to human pregnancy?

**P**: The blastocyst consists of trophoblast, an inner cell mass and a central cavity

**Q**: The morula becomes embedded in the endometrium during implantation

**R**: The placenta acts as an exchange mechanism between the mother and the fetus

**S**: Maternal and fetal blood are mixed while passing through the placenta

(A) **P** and **Q**

(B) **R** and **S**

(C) **Q** and **S**

(D) **P** and **R**

63. In *Drosophila melanogaster*, cherub wings (ch), black body (b) and cinnabar eyes (cn) are recessive to their corresponding alleles (represented as ch+, b+ and cn+, respectively) and are all located on chromosome 2. Homozygous wild type flies were mated with cherub, black and cinnabar flies and the resulting F1 females were test crossed with cherub, black and cinnabar males. The following progeny were produced from the test cross:

ch b+ cn 110

ch+ b+ cn+ 780

ch+ b cn 70

ch+ b+ cn 6

ch b cn 769

ch b+ cn+ 60

ch+ b cn+ 111

ch b cn+ 9

Total 1915

Of these three genes, which one is in the middle?

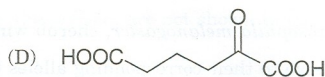
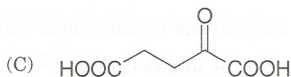
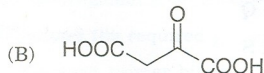
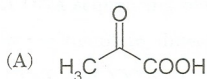
(A) The locus that determines cherub wings

(B) The locus that determines cinnabar eyes

(C) The locus that determines black body

(D) Cannot be determined from the given data

64. The enzyme that is used to make the first strand cDNA from mRNA is
- (A) Reverse transcriptase (B) Restriction endonuclease  
(C) DNA polymerase (D) T4 DNA ligase
65. Which one of the following compounds, on transamination, **DOES NOT** result in one of the genetically-coded 20 amino acids?



66. Choose the correct set of words denoted by **(P)**, **(Q)**, **(R)**, **(S)** and **(T)** to fill in the blanks.
- (P) use (Q) for antigen presentation. These antigen-displaying MHC molecules are recognized by (R), which express a unique co-receptor on their cell surface called as (S). On interaction with the antigen presenting cells, T cells respond by producing cytokines such as (T).
- (A) **P.** All nucleated cells; **Q.** MHC I; **R.** Cytotoxic T Cells; **S.** CD4; **T.** Perforins  
(B) **P.** Macrophages; **Q.** MHC II; **R.** Cytotoxic T Cells; **S.** CD4; **T.**  $\gamma$ -Interferon  
(C) **P.** B Lymphocytes; **Q.** MHC II; **R.** Helper T Cells (TH2); **S.** CD4; **T.** Interleukin-4  
(D) **P.** Dendritic Cells; **Q.** MHC I; **R.** Helper T Cells (TH1); **S.** CD8; **T.** GM-CSF
67. **Group I** lists relationships that can exist between two organisms. Their descriptions are given in **Group II**. Find the correct set of matches between **Groups I** and **II**.

**Group I****Group II**

- |                        |   |
|------------------------|---|
| <b>P.</b> Ammensalism  | <b>1.</b> One population is benefited and the other is harmed         |
| <b>Q.</b> Commensalism | <b>2.</b> Two dissimilar species living together in close association |
| <b>R.</b> Symbiosis    | <b>3.</b> Heterotrophic organisms that ingest other organisms         |
| <b>S.</b> Parasitism   | <b>4.</b> One population is inhibited but the other is not affected   |
|                        | <b>5.</b> One population is benefited but the other is not affected   |
- (A) **P-4, Q-1, R-2, S-3** (B) **P-3, Q-5, R-4, S-1**  
(C) **P-5, Q-4, R-3, S-5** (D) **P-4, Q-5, R-2, S-1**

68. Choose the correct set of matches between **Groups I** and **II**.

**Group I****Group II**

- |                     |           |   |
|---------------------|-----------|---|
| <b>P.</b> Embryoid  | <b>1.</b> | An unorganized growth of plant cells in a culture medium  |
| <b>Q.</b> Callus    | <b>2.</b> | A localized group of actively dividing cells from which permanent tissue systems such as root, shoot, leaf, and flower are derived                      |
| <b>R.</b> Meristem  | <b>3.</b> | A process whereby specialized, non-dividing cells begin to proliferate by mitotic division, presumed to involve regression to an undifferentiated state |
| <b>S.</b> Scutellum | <b>4.</b> | Mass of cells which has an external morphology resembling a proembryo   |
|                     | <b>5.</b> | The embryonic cotyledon of monocot plants   |

(A) P-4, Q-2, R-3, S-5

(B) P-4, Q-1, R-2, S-5

(C) P-3, Q-4, R-2, S-1

(D) P-2, Q-1, R-3, S-4

69. Match the hormones (**Group I**) to the glands producing them (**Group II**).

**Group I****Group II**

- |                         |                      |
|-------------------------|----------------------|
| <b>P1.</b> Oxytocin     | <b>R1.</b> Ovary     |
| <b>P2.</b> Insulin      | <b>R2.</b> Pituitary |
| <b>P3.</b> Calcitonin   | <b>R3.</b> Testis    |
| <b>P4.</b> Estrogen     | <b>R4.</b> Pancreas  |
| <b>P5.</b> Epinephrine  | <b>R5.</b> Thyroid   |
| <b>P6.</b> Testosterone | <b>R6.</b> Pineal    |
|                         | <b>R7.</b> Adrenal   |

(A) P1-R5, P2-R4, P3-R2, P4-R1, P5-R6, P6-R3

(B) P1-R4, P2-R6, P3-R5, P4-R3, P5-R7, P6-R1

(C) P1-R2, P2-R4, P3-R5, P4-R1, P5-R7, P6-R3

(D) P1-R1, P2-R4, P3-R7, P4-R1, P5-R6, P6-R5

70. The  $G_0$  phase of the animal cell cycle can occur

(A) just before the  $G_1$  phase

(B) just before the mitotic (M) phase

(C) during the  $G_2$  phase(D) late in the  $G_1$  phase

71. Which one of the following options correctly describes the import of  $P_i$  and ADP into the mitochondria?
- (A) By ADP –  $H^+$  antiport and  $P_i$  –  $H^+$  antiport  
(B) By ADP – ATP antiport and  $P_i$  –  $OH^-$  antiport  
(C) By ADP –  $OH^-$  antiport and  $P_i$  –  $OH^-$  antiport  
(D) By ADP – ATP antiport and  $P_i$  –  $H^+$  antiport
72. If the genotypes **Aa Bb Cc dd Ee** and **Aa bb Cc Dd Ee** are crossed, what will be the proportion of **AA BB CC DD EE** genotype among the progeny?
- (A) 1/32 (B) 1/64  
(C) 1/256 (D) Zero
73. An enzymatic reaction following Michaelis-Menten kinetics ( $K_m = 50 \mu M$ ) converts 10% of the substrate (initial concentration  $S_0 = 1 \text{ mM}$ ) to the product in 5 minutes. If the enzyme concentration is doubled and the substrate concentration is brought down to 0.1 mM in the initial reaction mixture, the time (in minutes) taken for 50% conversion will be approximately
- (A) 1 (B) 2  
(C) 2.5 (D) 12.5
74. Which one of the following statements regarding mitochondria is **FALSE**?
- (A) Oxidation of NADH present in the mitochondrial matrix is coupled to proton transport out of the matrix  
(B) Hydrolysis of ATP present in the mitochondrial matrix is coupled to proton transport out of the matrix  
(C) Cytochrome *c* mediates electron transfer from cytochrome *bc<sub>1</sub>* complex to cytochrome *aa<sub>3</sub>* complex  
(D) Cytosolic NADH is delivered to the mitochondrial NADH dehydrogenase complex by the glycerol-3-phosphate shuttle pathway
75. The shape of cholesterol is
- (A) planar (B) globular  
(C) cylindrical (D) helical

76. The vitamin, whose derivative is **NOT** a coenzyme of *E. coli* pyruvate dehydrogenase complex, is
- (A) pyridoxal (B) thiamine  
(C) niacin (D) riboflavin
77. For a given unicellular organism, which one of the following needs to be characterized only once?
- (A) Genome (B) Transcriptome  
(C) Proteome (D) Metabolome
78. A certain purified DNA sample was cut with two restriction endonucleases E1 and E2. The following results were obtained from agarose gel electrophoresis
- Sample cut with E1 alone: two bands of size 35 kb and 15 kb  
Sample cut with E2 alone: two bands of size 40 kb and 10 kb  
Sample cut simultaneously with E1 and E2: three bands of size 35 kb, 10 kb and 5 kb
- From these data, it can be inferred that the DNA has
- (A) two sites for E1 and one site for E2  
(B) one site for E1 and two sites for E2  
(C) one site each for E1 and E2  
(D) three sites for E1 and one site for E2
79. Which one of the following elements **NEED NOT** be present in an expression vector?
- (A) Selection marker to select for host cells containing the vector  
(B) Two different origins of replication  
(C) Promoter sequence upstream of the cloned gene  
(D) Unique restriction enzyme sites for insertional cloning
80.  $\Delta G^\circ$  for the hydrolysis of ATP to ADP and  $P_i$  is  $-32$  kJ/mol. This means that when ATP is hydrolyzed to ADP and  $P_i$  in a cell,
- (A)  $-32$  kJ/mol of free energy becomes available to the cell for utilization  
(B) free energy available to the cell cannot be more than  $-32$  kJ/mol  
(C) at least  $-32$  kJ/mol of free energy becomes available to the cell for utilization  
(D) free energy available to cell cannot be determined solely by the value of  $\Delta G^\circ$

81. The product obtained by heating an equimolar mixture of adipic acid and hexamethylenediamine is
- (A) Nylon 6 (B) Nylon 66  
(C) Polyurethane (D) Terylene

82. A mixture of  $\text{CH}_3\text{-CH}_2\text{-CH=CH}_2$  and HBr (slight excess) in ether **DOES NOT** show optical activity because
- (A) an achiral product is formed  
(B) a single chiral product is formed  
(C) the product formed is a racemic mixture  
(D)  $\text{CH}_3\text{-CH}_2\text{-CH=CH}_2$  and HBr do not react in ether

83. The correct match between the items of **Group I** and **Group II** is

**Group I****Group II**

P. Phosphatidic acid

1. Zwitterionic

Q. Triacylglycerol

2. Hydrophilic

R. Glycogen

3. Hydrophobic

4. Amphiphatic

(A) P-4, Q-2, R-3

(B) P-4, Q-3, R-2

(C) P-1, Q-4, R-2

(D) P-2, Q-3, R-1

84. The correct match between the items of **Group I** and **Group II** is

**Group I****Group II**

P. McLafferty rearrangement

1. UV-Vis spectroscopy

Q. Chemical shift

2. IR spectroscopy

R. Molar extinction coefficient

3. NMR spectroscopy

S.  $R_f$  values

4. Mass spectrometry

5. Thin layer chromatography

6. Gel electrophoresis

(A) P-1, Q-3, R-6, S-4

(B) P-3, Q-4, R-2, S-6

(C) P-4, Q-2, R-3, S-5

(D) P-4, Q-3, R-1, S-5

85. Which one of the following is paramagnetic?  
 (A) CO (B) N<sub>2</sub>  
 (C) NO (D) [NO]<sup>+</sup>
86. Which one of the following molecules has zero dipole moment?  
 (A) BF<sub>3</sub> (B) H<sub>2</sub>O  
 (C) CHCl<sub>3</sub> (D) HF
87. Which one of the following complex ions has a square planar geometry?  
 (A) [PtCl<sub>4</sub>]<sup>2-</sup> (B) [NiCl<sub>4</sub>]<sup>2-</sup>  
 (C) [Zn(CN)<sub>4</sub>]<sup>2-</sup> (D) [Cd(CN)<sub>4</sub>]<sup>2-</sup>
88. The set of quantum numbers,  $n = 2$ ,  $\ell = 2$ ,  $m_\ell = 0$ ,  
 (A) is forbidden  
 (B) describes an electron in a  $2d$  orbital  
 (C) describes an electron in a  $2p$  orbital  
 (D) describes one of the five orbitals of similar type
89. The rate equation for the reaction  $2X + 3Y \rightarrow Z$  is  $rate = k[X][Y]$ . Consider the following statements  
**P**: The unit of  $k$  is mol L<sup>-1</sup> s<sup>-1</sup>  
**Q**: The value of  $k$  is independent of the initial concentrations of  $X$  and  $Y$   
**R**: By doubling the concentrations of both  $X$  and  $Y$ , the rate is doubled  
 Then, which one of the following is **CORRECT**?  
 (A) **P** is true, **Q** is false, **R** is false (B) **P** is true, **Q** is true, **R** is false  
 (C) **P** is false, **Q** is true, **R** is true (D) **P** is false, **Q** is true, **R** is false

90. Consider the equilibrium reaction  $\text{N}_2\text{O}_4 (\text{g}) \rightleftharpoons 2\text{NO}_2 (\text{g})$ . If the total pressure of the equilibrium mixture is  $p$  and the degree of dissociation of  $\text{N}_2\text{O}_4 (\text{g})$  is  $x$  at 300 K, the partial pressure of  $\text{NO}_2 (\text{g})$  is

(A)  $\left(\frac{2x}{1+x}\right)p$

(B)  $\left(\frac{2x}{1-x}\right)p$

(C)  $\frac{2}{3}xp$

(D)  $2xp$

91. The correct match between the items of **Group I** and **Group II** is

**Group I**

**Group II**

P. Fehling's solution

1. Detection of aldehyde

Q. Ferric chloride solution

2. Detection of glucose

R. Schiff's base formation

3. Detection of phenol

S. Iodoform test

4. Detection of  $-\text{COCH}_3$

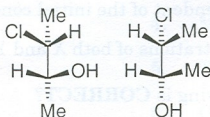
(A) P-2, Q-1, R-3, S-4

(B) P-4, Q-3, R-1, S-2

(C) P-3, Q-2, R-4, S-4

(D) P-2, Q-3, R-1, S-4

92. The two compounds given below are



(A) identical

(B) enantiomeric

(C) diastereomeric

(D) meso compounds



93. The correct match between the items of **Group I** and **Group II** is

**Group I****Group II**

**P.** Preparation of alkanes

**1.** Reimer-Tiemann

**Q.**  $C_6H_6 + C_2H_5Cl + AlCl_3$

**2.** Elimination reaction

**R.**  $C_6H_5OH + CHCl_3 + NaOH$

**3.** Friedel-Crafts

**S.**  $C_2H_5Br + KOH$  (alcoholic)

**4.** Wurtz

(A) **P-3, Q-2, R-1, S-4**

(B) **P-4, Q-3, R-1, S-2**

(C) **P-1, Q-3, R-2, S-4**

(D) **P-4, Q-2, R-1, S-3**

94. The acidity of

**P:**  $C_2H_5COOH$

**Q:**  $C_2H_5NH_2$

**R:**  $C_2H_5OH$

**S:**  $C_2H_5SH$

follows the order

(A) **P > S > R > Q**

(B) **P > R > S > Q**

(C) **S > Q > R > P**

(D) **R > Q > P > S**

95. The basic oxide amongst the following is

(A)  $Cl_2O$

(B)  $Na_2O$

(C)  $P_4O_{10}$

(D)  $SO_3$

96. The shape of  $[BrF_4]^-$  ion is

(A) regular tetrahedron

(B) square planar

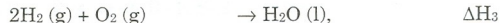
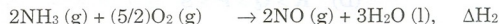
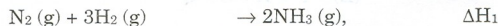
(C) trigonal pyramidal

(D) see-saw OR irregular tetrahedron

97. **Assertion [a]:** Dilute liquid ammonia solution of alkali metals (M) conduct electricity.  
**Assertion [b]:** The electrical conductivity is due to the formation of solvated electrons and  $M^+$  ions.

Which one of the following is **CORRECT**?

- (A) [a] is true but [b] is false  
 (B) Both [a] and [b] are false  
 (C) Both [a] and [b] are true and [b] is the correct reason for [a]  
 (D) Both [a] and [b] are true but [b] is not the correct reason for [a]
98. A zero order reaction is 50% complete in 30 minutes. The time (in minutes) from the start of the reaction required for 80% completion is
- (A) 42 (B) 48  
 (C) 52 (D) 60
99. The following data are given.



The  $\Delta H_{\text{net}}$  for the reaction  $N_2(g) + O_2(g) \rightarrow 2NO(g)$  is

- (A)  $\Delta H_{\text{net}} = \Delta H_1 + \Delta H_2 + \Delta H_3$  (B)  $\Delta H_{\text{net}} = \Delta H_1 + \Delta H_2 - \Delta H_3$   
 (C)  $\Delta H_{\text{net}} = -(3/2)\Delta H_1 + \Delta H_2 - \Delta H_3$  (D)  $\Delta H_{\text{net}} = \Delta H_1 + \Delta H_2 - (3/2)\Delta H_3$
100. From the data given below



the calculated  $E^\circ$  for  $A^{2+} \rightarrow A^{3+} + e$  is

- (A) +0.19 V (B) +0.73 V  
 (C) +1.37 V (D) +1.79 V

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